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FINAL CLOSE-OUT REPORT FY '06 - FY '10
DARPA agreement HR0011-06-1-0028

The Robert C. Byrd Institute for Advanced Flexible Manufacturing (RCBI) is pleased to submit the final report for agreement HR0011-06-1-0028 to the Defense Advanced Research Projects Agency (DARPA).

Introduction and Background

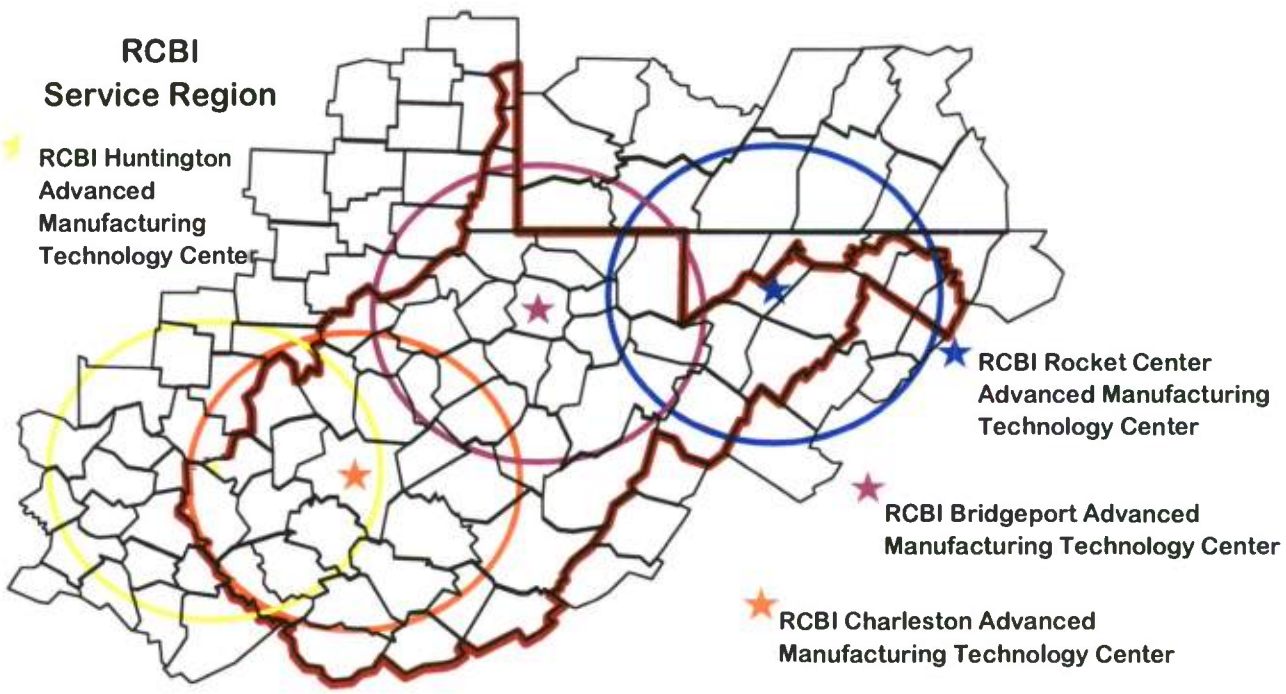
The mission of RCBI is to develop a capable, responsive and high quality manufacturing supplier base for the Department of Defense (DoD) and its commercial sector markets. This focused mission includes particular research & development activities on behalf of and with its manufacturing client base.

RCBI has worked with manufacturers across its service region to improve their manufacturing and operational practices. RCBI introduced innovative new technologies and provided affordable technical training through a variety of multi-media strategies as well as continued its well respected "hands-on" approach of shop-floor assistance and access to the latest computer-controlled manufacturing equipment. RCBI maintained direct contact with industrial developments, DoD agencies and their primes across the country to bring new approaches, applied research & development activities and technologies to manufacturers throughout its service region. Further, RCBI worked to build and encourage links among manufacturers across its service region, as well as ones with DoD offices and their primes that needed specialized manufacturing capacities; this effort encouraged mutually beneficial business interactions through effective networking and partnership opportunities.

RCBI worked to build and enhance linkages between manufacturers in its service region and DoD offices that have the need of a specialized manufacturing capacity. RCBI also worked to bring the manufacturing base of the region together with major suppliers to the DoD.

Service Region

During the term of the grant, RCBI served all of West Virginia and portions of Pennsylvania, Maryland, Virginia, Kentucky and Ohio primarily from four West Virginia-based Advanced Manufacturing Technology Centers that are positioned to uniquely serve individual manufacturers in each region. However given RCBI's capabilities, its state-of-the-art service offerings have been completed in 17 states across the United States, including Alabama, California, Florida, Georgia, Illinois, Michigan, Mississippi, New Hampshire, New Jersey, North Carolina and Washington.



Each RCBI Advanced Manufacturing Technology Center – located in Huntington, Charleston, Bridgeport and Rocket Center – defines a sub-region with a radius of approximately 60 to 100 miles from which RCBI principally draws manufacturing client companies. Each sub-region has a concentration of manufacturers with similar needs and markets; however, each sub-region maintains its own distinct industrial focus.

Accomplishments During the Period of the Grant

During the term of the grant, RCBI's dynamic, sharply focused, statewide service delivery system was fully operational and making a difference to the state's and region's manufacturers. RCBI served more than 5,300 manufacturers that employed nearly 81,000 individuals across West Virginia and the surrounding region. In addition, RCBI identified and served 450 regionally located companies that are quality certified and which can and did deliver parts, components, on-time, quality-certified to the DoD and commercial primes. Each RCBI Advanced Manufacturing Technology Center is fully equipped with computer-controlled and production-ready equipment, applied research & development areas, cutting edge design software, state-of-the-art computer labs, manufacturing staff expertise, training resources, as well as video-teleconference capabilities that are available to West Virginia's and the region's manufacturers.

RCBI had a positive, measurable impact during the term of the grant. Activities of the Robert C. Byrd Institute for Advanced Flexible Manufacturing were directly responsible for bringing nearly 1,000 highly skilled and higher paying jobs to the region, translating into $43 (M) million in incremental incomes. The average employee salary was roughly $44,000 – nearly two-thirds more than the average West Virginian's salary. RCBI contributed either directly or indirectly to a $312 (M) million increase in total output by West Virginia companies using its services.

To introduce the potential trillion dollar industry that Nanotechnology represents to manufacturers and entrepreneurs, RCBI teamed with Marshall University, the Center for Diagnostic Nanosystems and Michigan Technological University to focus on the commercial potential of this industry. A series of seminars was conducted to showcase the potential for job creation and economic impact that West Virginia stands to realize from the use of Nanotechnology in manufacturing, research, healthcare and medicine and other fields. RCBI brought national experts to West Virginia to address the importance of the technology, the benefits for industry as well as the public and where it was headed.

RCBI started its own Design Works labs in an effort to provide manufacturers, entrepreneurs, students, machinists and engineers with access to a one-stop shop and turn their ideas and talent into new products. From a concept drawn on a napkin or the back of an envelope to a 3D design to a working prototype and on to either limited- or full-rate production, Design Works at RCBI provides a full range of manufacturing solutions. Design Works made it possible to convert an inspiration to reality. This service merely formalized the process that was always available at RCBI. It was used to promote, encourage and nurture innovative talent in an effort that helped develop ideas into practical, sustainable and viable manufactured items. The initial Design Works labs were operated from RCBI Advanced Manufacturing Technology Centers in Huntington and Charleston

RCBI hosted seminars, demonstrations and open house opportunities for manufacturers and entrepreneurs across the service region during which national and international technology vendors as well as machine tool and industrial supply companies made their product lines available. The technology/tool vendors and suppliers include: Accupro, Advanced Solutions, Allegheny Machine Tool, Allegheny Petroleum, Amada, Amtek Company, Aurora Flight Sciences, Azimuth, Bondtech, Clausing Industrial, Davis Taylor Forster Co., ESGR (Employer Support of the Guard and Reserve), Euro-Composites, FARO, Flow International, Gibbs, Greenfield, Haas, Hexagon Metrology, Inspection Engineering, Iscar, Kennametal, Kennedy Manufacturing Co., Konica Minolta, Kyocera, Mabscott Supply, Machining ROI, McClean Anderson, Metal Cutting Specialists, Mountain CAD Corp., MSC Industrial Supply Co., the National Center for Defense Manufacturing and Machining (NCDMM), Northwood, Parlec, Ralph A. Hiller Co., the Robert C. Byrd National Aerospace Education Center, Sabatelli Precision Grinding, Sandvik Coromant, Simonds, Starrett, Sterling Supply Co., Stratasys, Sumitomo, Tecnomagnete, Touchstone Research Laboratory, TriMech Solutions, Wohlhaupter Corp., the West Virginia National Guard and Wynn Frick Consulting.

RCBI continued Research & Development activities closely tied to its DoD-focused mission. Specific R&D efforts involved projects for more complex manufacturing issues, from techniques in the design process to initial prototype production through actual production and unit testing. Projects included curing processes that assisted in the development of new, advanced carbon materials for aerospace uses; manufacturing, training and technical installations assistance with prototype carbon-fiber laminate sheets; reverse engineering and re-design assistance; development of titanium matrix aircraft components; production, assembly and testing of alignment tools for shipboard pipefitting; prototyping DNA synthesis equipment; and laser scanning that captured detailed part dimensions and configurations. This work was extended in areas of metal matrix composites for landing gear actuators; aluminum and fiber composite material for pressure vessels, and environmental encapsulation of RFID sensors for military logistics management. Particular R&D activities included:

- Provided technical assistance to Boeing Phantom Works and Cytec Advanced Materials, in development and refinement of an out-of-autoclave curing process for fabrication and repair of composite-material panels using heat without pressure. The goal was to identify new materials and procedures to fabricate and repair composites materials.
- Provided expertise and technical assistance to Touchstone Research Laboratory, Ltd. of Triadelphia, West Virginia, in development of a new aluminum and fiber composite material, MetPreg.
- Delivered technical assistance as well as manufacturing and production to FMW Composite Systems Inc. of Bridgeport, West Virginia, in development and fabrication of titanium matrix and metal components for a variety of aircraft applications for Boeing Aircraft, GE Engines and Rolls Royce Engines.
- Provided software engineering and programming assistance, workforce training and access to its McClean Anderson WSH Flex Filament Winder technology to Williams International, a Wisconsin-based composites manufacturer, which produced a first article carbon fiber cylindrical casing for a DoD classified weapons platform.
- Worked with Oculus Development, LLC of Morgantown, W. Va., and assisted in the manufacture of a prototype of an all-composite radome that was for use on a biometric and surveillance antenna array modification of a C-130 gunship configuration for the U. S. Air Force.
- Provided engineering design assistance, CAD modeling, prototyping and water-jet cutting for Walhonde Tool, Inc., a manufacturer in South Charleston, W. Va., for production and assembly of a new series of pipefitting alignment tools that benefits the DoD.
- Provided customized Mastercam and production assistance for Touchstone Research Laboratory, Ltd. in research & development that involved production of advanced coal-based CFoam material used to produce molds for Sikorsky Aircraft Black Hawks.
- Provided technical assistance, engineering assistance, production preparation, manufacturing and inspection of components for prototype craft wing and other ancillary molds for the Global Hawk UAV (unmanned aerial vehicle). The project resulted in full-rate production of the molds and fulfilled a DoD contract.
- Provided technical expertise, programming and technical assistance for 6-axis machining of carbon-composite molds for Touchstone Research Laboratory, Ltd. that was used in the development of a carbon-composite missile canister mold for the military.
- Delivered engineering assistance, prototyping and production assistance in the development of an innovative cave monitoring technology that offered the ability to detect confined environments and determine its contents and/or inhabitants.

Resources/Facilities

The RCBI Huntington Advanced Manufacturing Technology Center served nearly 4,300 manufacturers that employ more than 71,000 individuals across its multi-state service region. The RCBI Huntington facility focused on the metals manufacturing, tool & die, and heavy-equipment parts production markets as well as provided reverse engineering assistance, CAD/CAM and other high end software engineering assistance.

Access to the latest advanced machining and development capabilities resulted in manufacturers expanding their competitive capabilities so they lowered their production costs, improved production efficiency, maintained tight tolerances and thus greatly controlled – and greatly enhanced – the quality of their products.

Specialized technologies and state-of-the-art and -market equipment available to private industry on a shared – or leased use – basis at RCBI Huntington included:

- Amada High Precision Hydraulic CNC Press Brake with 90-ton capacity
- Charmilles Technologies Robofil 440cc Submersible Wire EDM Center
- Mazak Integrex Mark 3 ST Multitasking Machine
- Okuma LU370BBM 4-axis CNC Turning Center with live tooling
- Amada Pulsar 1212XL 2000-watt Laser Cutter
- Mazak VCN-510 Vertical Machining Center
- Kitamura 7X Vertical Machining Center
- Starrett SPC Equipment
- Alpha Harrison 460 CNC/Manual Lathe
- Parlec Tool Presetter
- Stratasys FDM Rapid Prototype Machine
- Handyscan 3D Digital Laser Scanner
- FARO Arm CAM2 Measurement System
- FARO Laser ScanArm
- Sheffield Measurement (Giddings & Lewis) Cordax Coordinate Measuring Machine
- HYD-MECH Programmable Horizontal Band Saw
- State-of-the-art videoconferencing equipment
- Clausing 15x50 Lathes
- Drake V-16 Vertical Band Saws
- Willis Big Bear 1100 Radial Drill Press
- Willis Model 1050 Manual Turret Mills
- Jafo FWF-32J Horizontal Mill
- HE&M Twister Horizontal Cut-off Saw
- Baldor 1021wd Pedestal Grinders
- Acer AGS 1020 ADH Surface Grinders
- Pentium Computer Lab

The RCBI Charleston Advanced Manufacturing Technology Center served nearly 1,100 manufacturers that employed more than 16,150 individuals. The Charleston facility focused on the metals manufacturing and fabrication, chemical production, and heavy-equipment parts production markets as well as provided a multitude of training opportunities on equipment controls, programming and software design.

Specialized technologies and state-of-the-art and -market equipment available to private industry on a shared – or leased use – basis at RCBI Charleston included:

- Fortus 900mc 3D production system for direct digital manufacturing and functional rapid prototyping, conceptual modeling and limited-rate production
- Dimension 3D Printer
- Star SR-20J Swiss Type CNC Machining Center
- Flow International 4 X 8 Flying Bridge CNC Abrasive Water-jet Dynamic Cutting System
- Okuma MX-60HB Horizontal Machining Center
- Okuma LU15 CNC Turning Center

- Okuma MA-650 CNC Vertical Machining Center
- Haas TL-3 CNC/Manual Lathe
- Handyscan 3D Digital Laser Scanner
- FARO Laser ScanArm
- Starrett SPC Equipment
- Bridgeport Series 1 Mill
- Willis 15x50 Lathes
- HE&M Twister Horizontal Cut-off Saw
- Baldor 1021wd Pedestal Grinders
- State-of-the-art videoconferencing equipment
- Pentium Computer Lab

The RCBI Bridgeport Advanced Manufacturing Technology Centers, focused on both metals and composites, served more than 800 manufacturers and worked with more than 16,500 employers and employees from the aerospace industry. The RCBI Bridgeport facility focused on aerospace, aeronautics and other commercial and defense markets. Specialized technologies were added to enhance the growing industrial base across the region and were the catalyst for the region's companies to develop new products and processes as well as secure and maintain contracts with the DoD and NASA. RCBI became recognized as a national leader in specialized technologies and composites-sector offerings through efforts including establishment of the RCBI Composites Technology & Training Center.

From an approximate 27,500-square-foot facility in the Harrison-Marion Regional Airport's Benedum Industrial Park, RCBI Bridgeport provided service to neighbors and clients that included Bombardier Services, Northrop Grumman, Pratt-Whitney, Aurora Flight Sciences, Boeing, Lockheed Martin and FMW Composite Systems Inc., to name a few local manufacturers.

RCBI operated separate metals-oriented (DARPA-funded) and composites-oriented (NASA-sponsored) centers in Bridgeport. During this period management worked to integrate the centers into a single organization, with the objective of improved coordination and enhanced service levels for client companies.

Specialized technologies and state-of-the-art and -market equipment available to private industry on a shared – or leased use – basis at RCBI Bridgeport included:

- Fryer Easy Turn 30 CNC Lathe with Steady Rest and Following Rest
  Designed to satisfy machinists' needs, the Easy Turn represents high quality and value with trouble free use. This model is easier to use than a conventional lathe, and offers the productivity of a CNC lathe. Time consuming manual set-ups are eliminated by its handle-driven "Do-One" cycles and electronic stops.
- Metal Disintegrator
  This equipment offers the ability of disintegrating and removing broken tooling, studs, taps (up to 1.25"), and drills without damaging the internal hole in the part.
- Cincinnati Machine Hawk CNC Turning Center
  The Cincinnati "Hawk" features a 12-station quick-change tooling turret and sits in a smaller "footprint" on the shop floor, in contrast with comparable lathes. It is fitted with a 3 ½ inch hole through spindle and a 12 inch chuck. It can handle parts up to 44 inches in length.
- Cincinnati U5 6-axis CNC Machining Center
  The 6-axis served the aerospace industry's need for oversized and exotic parts production. These abilities enabled manufacturers to bid jobs they otherwise might have to pass up due to the size and

productivity limitations of lesser technology. RCBI expanded the 5-axis machining center, by adding a rotating table for sixth-axis positioning and a highly specified Siemens control, and resulted in RCBI having the only one of its kind, readily available, manufacturers' resource available for shared on the East Coast.

- Okuma MX-55VB CNC Vertical Machining Centers
- Okuma Crown CNC Turning Centers
- Starrett SPC System
- Bridgeport-type Series 1 Mills
- State-of-the-art videoconferencing equipment
- Pentium Computer Lab
- Bondtech Composite Autoclave with Programmable Chart Recorder and paperless recorder capable of 600 degrees F and 200 PSI
- Clean Air Technology "Softwall" Cleanroom
  Earned the designation as surpassing standards for an ISO 14644-1 and ISO 14644-2 Class 6 clean zone/Fed Standard 209E Class 1000.
- Handyscan 3D Digital Laser Scanner
- Matec Non-destructive Testing (NDT) Equipment
  Non-destructive Testing equipment available in RCBI's Metrology lab, which served the aerospace, aeronautics, ordinance, transportation, construction, chemical, petrochemical, energy, composite tooling, safety glass and metallurgical industries, performed non-destructive analysis of the structure and composition of the material to detect anomalies.
- The McClean Anderson WSH Flex Filament Winder
  The WSH offered computer-controlled motion and employs all-digital AC servo technology. The WSH is driven by powerful Windows®-based *flexwind* machine control and Composite Designer pattern development software and is well optioned to meet manufacturers' specific winding requirements to serve industries ranging from DoD aerospace and munitions requirements to commercial automotive and athletics markets.
- Coordinate Measuring Machine (CMM)
  The CMM offered dimensional testing and reverse engineering when older parts needed to be replaced. By improving inspection abilities from those obtained from hand tools and reducing the time involved in the process, CMMs ensure the quality of a product for manufacturers and reduce scrap rates.
- Matec Ultrasonic Immersion System
  Immersion tank systems are extremely flexible and adaptable ultrasonic testing systems designed to inspect a diverse range of components for industry.
- Nondestructive Ultrasonic Squirter System
  The ultrasonic squirter system is used to perform non-destructive evaluation of the structure and composition of parts to detect subsurface anomalies using ultrasonic testing techniques to ensure the quality of the part.
- FARO Arm CAM2 Measurement System
- Leica Q5001W Imaging Workstation
- Northwood 5-axis CNC Router
  This versatile, high speed machine offers manufacturers flexibility in programming and is especially useful in the aerospace, composites, plastics and woodworking sectors.
- Flow International Flying Bridge CNC Abrasive Water-jet Cutting System

- Precision Quincy Corp. Curing Oven
- Cutting Room
- Laser Tracker
- Laser Scanner
- Real-time X-Ray
- Downdraft Benches
- HP Designjet 750C Plus Color Plotter
- Willis 15x50 Lathes
- Drake V-16 Vertical Band Saw
- Willis Big Bear 1100 Radial Drill Press
- Jafo FWF-32J Horizontal Mill
- HE&M Twister Horizontal Cut-off Saw
- Baldor 1021wd Pedestal Grinder

The RCBI Rocket Center Advanced Manufacturing Technology Center, in the eastern hills of West Virginia on the site of a Navy Co-op with Allegany Ballistics Laboratory's West Virginia operations, serves as a very specialized training arm of RCBI, housing particular technologies focused on preparing the workforce for specific, just-in-time DoD contract opportunities. Workforce training focused on computer-controlled skills as well as customized machinist training and solder certification to meet specific contract requirements. RCBI further served the specialized needs of the region's industry when it developed and provided safety training in a variety of areas, including ergonomics topics, to more than 1,200 workers.

RCBI established its Master & Advanced Solder Center of Excellence at its Rocket Center Advanced Manufacturing Technology Center. From this high-tech facility that was outfitted for professional soldering, with high clarity projection graphics and fully equipped soldering stations, RCBI delivered IPC CIS and CIT-level training services that included IPC-A-610, IPC-A-620, IPC-JSTD-001 and IPC-7711/7721. RCBI trained and certified nearly 200 workers in the necessary solder skills and met rigorous industry standards.

Specialized technologies and state-of-the-art and -market equipment available to private industry on a shared – or leased use – basis at RCBI Rocket Center included:

- The Haas TM-2 Toolroom Machining Center
  The TM-2 features the new Haas Intuitive Milling System software. It is extremely easy to set up and operate, even if operator doesn't know G-code programming. For extreme flexibility, it operates in three modes: manual, combined manual/CNC and full CNC.
- Alpha Harrison 460 Plus CNC/Manual Lathe
  The "460 Plus" offers manufacturers the ability to allow an operator, untrained on CNC equipment, to gradually transition his/her abilities to full CNC abilities, while more easily operating the controls of the lathe.
- American Autoclave with paperless recorder
- Handyscan 3D Digital Laser Scanner
- Instron Materials Testing Instrument Model 5582
- Bridgeport-type Series 1 Mills
- Willis 15x50 Lathes
- Drake V-16 Vertical Band Saw

- Baldor 1021wd Pedestal Grinder
- State-of-the-art videoconferencing equipment
- Pentium Computer Lab

Staff Expertise

During the term of the grant, RCBI continued to develop a strong, capable staff oriented to the delivery of needed services across its service region. The collective backgrounds of individuals at RCBI bring expertise in both traditional and CNC machining as well as Prototyping and 3D Printing; CAD/CAM; SurfCAM, SolidWorks, Solid Edge, Rapidform, Mastercam, Inventor, Geomagic, FeatureCAM, FARO CAM2, Esprit, DezignWorks, CMM-Manager, AutoCAD and 3D-Doctor software; Automotive Technology, including ASE Master Automobile Technician and ASE Engine Assembly Specialist certification; process improvement; supply chain management; plant management; Master Electrician; CNC process management and programming; NC Machine tool engineering and supervising; diagnostic equipment and maintenance; MIG, TIG and ARC welding; Solder certification and training (delivering IPC CIS and CIT-level training services including IPC-A-610, IPC-A-620, IPC-JSTD-001 and IPC-7711/772); Non-destructive Testing inspection; electrical design specialty; process/manufacturing engineering in composites structures; PLC programming; IEC and NEC print experience; Quality and Environmental Management Systems implementation and certification including ISO 9001, ISO 14001; 5S Manufacturing initiatives; Six Sigma; Lean; Technical Education Counseling; Electrical; PLC; robotics programming; and IT expertise including CCNA, CCDA, CCNP, Network +, IP Telephony, Wireless LAN specialists, MCP, BICSI, Microsoft, Cisco, Novell, Linux and Dell to the manufacturing sector across the RCBI service region.

To accommodate the growing needs of industry, RCBI staff members have industry-based, composites-materials experience that includes fabrication, mold making, bonding and repair for client project activities as well as technical training courses; the ability to assist in development of composites training materials and hands-on projects; knowledge of Non-Destructive Testing (NDT) methods, Reverse Engineering, Prototyping and Measurement with CMM use; knowledge of Geometric Dimensioning & Tolerancing (GD&T); Federal Aviation Administration (FAA) Aircraft and Power Plant inspection and certification; the ability to provide both formal classroom and On-The-Job Training (OJT); knowledge of manufacturing software (including CAD - Pro/E, CNC Programming, Mechanical Desktop, Solid Edge, CAM – SurfCAM, Mastercam, Virtual Gibbs), adhesive bonding of composites and Quality Assurance; knowledge of Environmental Management Systems Standards; the ability to read blueprints and interpret drawings; skill in design/fabrication of composites tooling, and knowledge and experience with continuous improvement tools and methods.

RCBI's broad and deep expertise, which during the term of this grant was available to manufacturers 24 hours a day every single day of the year, represents more than 600 years of industrial experience. RCBI directly employs 34 individuals – a number that quickly rose, at times, to more than 70 with subcontractors.

In addition to internal staff expertise, RCBI partnered with various organizations to accomplish a variety of tasks. Partners included:

NATIONAL

- U.S. Navy
- Office of Naval Research
- Defense Logistics Agency
- NASA Langley Research Center
- NASA Goddard Space Flight Center
- Man Tech International

STATE

- State of West Virginia
- the Region's Business Community
- Marshall University
- Marshall Community & Technical College (MCTC)
- West Virginia Development Authorities
- West Virginia Manufacturers Association

- Lockheed Martin
- Lockheed Martin Skunk Works
- Boeing
- National Composite Consortium (NCC)
- Western Governors Association
- The 130th Airlift Wing of the Air National Guard
- National Association of Manufacturers (NAM)
- Virtual Parts Supply Base (VPSB)
- National Technological University
- Orbital Science Corporation
- Online Quotes from **www.mfgquote.com**
- Society of Manufacturing Engineers
- Business Electronics Soldering Technologies Inc.(BEST)
- American Composites Manufacturers Association (ACMA)
- The Composites Manufacturing Technology Center - the Navy Center of Excellence for Composites Manufacturing Technology
- Michigan Technological University
- Distance learning from **ToolingU.com**
- National Energy Technology Laboratory (NETL)
- West Virginia Chambers of Commerce
- Polymer Alliance Zone
- Potomac State College of WVU
- West Virginia Northern Community College
- West Virginia University (WVU)
- Zane State College
- West Virginia vocational-technical centers
- WVU Institute of Technology
- Allegany Co. (MD) Career Center
- Mine Safety and Health Administration
- UMWA
- West Virginia Development Office
- Dow Chemical
- West Virginia K-12
- West Virginia Robotics Teams
- WV and PA MARS FLL Robotics Teams

Service Units

RCBI's internal structure provided fully integrated, complete manufacturing technology offerings to small and medium-sized manufacturers across a statewide, four-site system on-site 24-hours-a-day/7-days-a-week. As detailed throughout this close-out report, the various service units complement each other and combine efforts whenever needed to serve client companies effectively.

Technical Services offered specialized, state-of-the-art, manufacturing equipment, programming, prototyping as well as a host of other related offerings, available at RCBI Advanced Manufacturing Technology Centers, and had nearly 500 years of hands-on equipment-related manufacturing experience, delivered customized and general technical, administered all technology transfer projects. During the term of this grant, each site was managed on a daily basis by senior manufacturing engineers and further staffed with manufacturing technicians, quality specialists, safety specialists, systems integration staff, as well as other focused and pertinent individuals.

The RCBI Technical Services group offered companies specialized technologies to deliver contracts by leasing time on state-of-the-art production equipment while simultaneously providing the latest training and programming assistance to employees. Technical Services introduced specialized technologies and just-in-time manufacturing processes, and served as a catalyst for industrial development and contract

delivery. Technical Services made it possible for manufacturers of all sizes to fulfill contract requirements including specific requirements, tolerance specifications, just-in-time mandates, as well as provided training, leased time on equipment, offered programming assistance and set-ups to ensure quality driven components for projects including the Global Hawk UAV and its V-tail Aft Composites Wing section. A specific project that demonstrates the technical aspects of services at RCBI involved space shuttle needs for the nation's space program. A West Virginia manufacturer received an R & D opportunity to design, develop and produce a prototype Super Light Weight Interchangeable Carrier (SLIC) pallet through a multi-phase contract. As a direct result of RCBI assistance and access to its service offerings – including access to computer-controlled equipment, technical training and quality assistance – this manufacturer delivered on this series of contracts worth in excess of $18 (M) million.

With integration of metals and composites-manufacturing technology and training assistance, RCBI achieved the objective of improved coordination and enhanced service levels for client companies. Further, this focus resulted in RCBI providing additional services to all of West Virginia and 17 states across the United States.

The integration of metals and composites-manufacturing equipment resulted in more technology for manufacturers and included:

- Browne & Sharpe TORO Runway FB2 Model 60.16.21 Coordinate Measurement Machine with PC-DMIS Pro Metrology software
- Flow International I-4800 Integrated Flying Bridge Abrasive Water-jet Cutting System
- Bondtech Composite Autoclave with Programmable Chart Recorder and paperless recorder capable of 600 degrees F and 200 PSI
- Quincy Corp. Curing Oven
- Clean Air Technology "Softwall" Cleanroom
- Matec Non-destructive Testing (NDT) Ultrasonic Immersion Inspection Equipment
- Matec Non-destructive Testing (NDT) Ultrasonic Squirter Inspection System
- Real-time X-Ray
- Cutting Room
- Northwood 5-axis CNC Router
- McClean Anderson WSH Flex Filament Winder
- Tinius Olsen H100K-S Benchtop Universal Material (Tension) Testing Machine
- Sheffield RS150 Coordinate Measurement Machine
- FARO Arm CAM2 Measurement System
- FARO Laser Tracker
- Handyscan 3D Digital Laser Scanner
- Omega Digital Anemometer

The RCBI Technical Services group provided technical manufacturing assistance to more than 4,000 companies that ranged in size from two (2) employees to nearly 1,500 employees. These manufacturers and start-up companies received technical assistance that met their programming, product development and production requirements, which allowed them to diversify and grow.

TECHNOLOGY TRANSFER

As a direct result of exposure and trial use of RCBI's specialized, computer-controlled, production equipment and state-of-the-art technologies, more than 200 pieces of cutting edge, computer-controlled equipment at a value approaching $32 (M) million were acquired by private industry in the region served by RCBI. RCBI scheduled seminars attended by national machine tool representatives from equipment vendors as well as its own technical staff members in an effort to demonstrate hardware and software capabilities to local manufacturers. The seminars exposed manufacturers and entrepreneurs to the latest, specialized computer-controlled, production equipment available at RCBI for leased use. RCBI partnered

with national tool vendors, software companies and suppliers including Ally PLM Solutions, Inc.; Blue Ridge Machinery and Tools; FARO Technologies; Kennametal; Kyocera; Mastercam; Okuma; Sandvik Coromant; SECO Carboloy; Stratasys and Sterling Supply (among others) to supply the latest technology and solutions to manufacturers and entrepreneurs across the state and region.

During the term of this grant, RCBI was able to boast the success of a first NASA technology transfer and commercialization in the Mid-Atlantic states' region that benefited private industry. This success was the result of concentrated efforts by RCBI to form partnerships and collaborations between private industry participants, the NTTC and the NASA Langley Research Center to bring high-level prototype technology testing to West Virginia. With use of this high-level catalyst technology -- Low Temperature Oxidation Catalyst Technology Formaldehyde abatement -- industries in West Virginia focused on chemicals, composites, automotive and wood/fiber were able to reduce emissions and expand their operations and markets. RCBI's private industry partner identified 20 manufacturing plants across the region that had a potential interest in installation of this technology at their facilities to comply with EPA regulations. A prototype of this effort is continuing to be developed, and is expected to reduce formaldehyde emissions, create jobs and expand the manufacturing base.

RCBI worked closely with companies participating in the RCBI 21ST Century Manufacturing Network (**www.21stmanufacturing.org**) to identify and provide quality manufacturing options to the new hydrogen fuel production plant and vehicle fueling station at the Yeager Airport in Charleston, W.Va. This U.S. Department of Energy energy-prototype project involved the construction and operation phase of the hydrogen production plant. From a small, automated production plant like the one envisioned at Yeager Airport, hydrogen fuel can be produced for the equivalent of about $2.10 a gallon at conventional gasoline prices. The Yeager-based 130th Airlift Wing of the Air National Guard is receiving several hydrogen-burning vehicles as a component of this energy project.

Workforce Development and Technical Training directs efforts to educate and train individuals so their technical abilities were fully developed to meet manufacturers' demands. Technical course offerings were tailored to meet manufacturers' individual needs in areas ranging from basic blueprint reading to introductory and advanced CNC machining on specialized technologies including a Fortus 3D production system for direct digital manufacturing and functional rapid prototyping, conceptual modeling and limited-rate production; an Integrex multitasking machine, a Mazak machining center, a laser cutter, a water-jet cutter, a Fryer Easy Turn lathe; a 6-axis machining center and a "Swiss Turn." Programmable Logic Controller (PLC), CAD/CAM, Programming, Electrical, and Safety issues training have also been customized and presented to manufacturers across the RCBI service region. RCBI provided customized technical training and workforce development skills to nearly 18,500 workers who represented nearly 4,000 companies that ranged in size from two (2) employees to nearly 1,500 employees.

WORKFORCE DEVELOPMENT

During the term of this grant, RCBI developed and initiated the nationally certified RCBI Machinist Technology Program. This "teaching factory of the future" – certified by the National Institute for Metalworking Skills (NIMS) – is ongoing at the RCBI Advanced Manufacturing Technology Centers in Huntington, Bridgeport and Rocket Center. Each RCBI facility has earned certification from NIMS. Several courses in the Machinist Technology Program use distance learning and simulations as component parts of their dissemination. Nearly 320 individuals had completed hands-on coursework in the Machinist Technology Program at the statewide Advanced Manufacturing Technology Centers. These individuals had entered the work force earning wages that ranged from $10 an hour to $16 an hour with benefits. This successful program boasts a 94 percent industry placement rate and a 100 percent career advancement rate for its graduates. Each individual who completes the program is required to earn individual credentials in at least three (3) of seven (7) machining skill-sets categories set by NIMS; the graduates earned more than 1,300 individual credentials from NIMS. The RCBI program is one of the first in the nation to couple its machinist certification with a two-year college degree opportunity. One-hundred-nineteen (119) of the program's graduates earned Associate degrees; others are in the process through their local community colleges. The training program produced nationally (NIMS) certified machinists for immediate employment in the region's industrial base, minimized the amount of re-training required after initial employment, and created a pool of technically talented individuals for the manufacturing sector. An

11-member Industry Advisory Board helped identify the curriculum needs and continued to counsel the RCBI Machinist Technology Program.

The focused machinist training continues to be available in both full- and part-time options at three of RCBI's statewide facilities; it was customized and delivered in part-time scheduling for manufacturers in two shifts in Bridgeport, as it has been for other manufacturers at other RCBI facilities as needed. More in-depth CNC coursework has been added to the curriculum in reaction to industry need.

Because of its proven success, the RCBI Machinist Technology Program offers exactly the type of training program that can serve as a model training resource for organizations that wish to incorporate a degree option with NIMS credentialing. This was the finding of NIMS, which referred RCBI as a model program worthy of replication to several community colleges across the nation that wish to integrate their offerings with nationally recognized NIMS credentialing. Shoreline Community College near Seattle, Washington and Clark College in Vancouver, Washington, to name a couple, are in the process of visiting the RCBI program to determine how best to extend such focused workforce skills training to their schools' offerings.

RCBI introduced a full-time CNC Specialist Program, modeled after its award-winning Machinist Technology Program, in response to a nationwide shortage of skilled CNC machinists and operators. Nine (9) individuals had completed its coursework and earned 18 individual credentials from NIMS, as well as an Associate degree upon completion of community college requirements.

RCBI demonstrated success in conducting multiple customized training programs utilizing skills assessment tools, developing company specific training schedules, and providing full level implementation.

During the period of the grant-term, RCBI provided advanced composites training to meet requirements of NASA Servicing Engineers. This activity expanded RCBI service outreach to the Baltimore and the greater DC metropolitan areas and filled a skilled workforce deficiency along the East Coast.

The NASA Goddard Space Flight Center in Greenbelt, Md., contracted with RCBI to support developmental requirement projects including the two-stage Crew Exploration Vehicle/Crew Launch Vehicle (CEV/CLV). Both CEV and CLV are key elements of NASA's detailed plan to support sustained human and robotic lunar exploration operations for missions to the International Space Station, among others. RCBI also successfully completed various levels of composites training at the Marshall Space Flight Center. RCBI also provided composite machining training to NASA Goddard.

During the term of this grant, RCBI reinstated its Manufacturing Engineering Program, a partnership program with the Marshall University Community & Technical College (MCTC), as well as prepared more than 500 courses that were offered to the general public or customized for individual companies.

Quality Certification developed and implemented registered quality management systems for proper documentation to ensure effective suppliers in the supply chain. Beyond compliance or registration, RCBI recognized that manufacturers needed other tools to improve their processes and systems. Specific areas that RCBI covered included military specs (and those that involve the automotive and aerospace industries); ISO 9001; ISO 14001 – Environmental (Green Manufacturing); QS-9000 and TS16949: 2002; AS9100; Lean Manufacturing; Value Stream Mapping; Cycle Time Analysis; Six Sigma initiatives and Supervisory Management.

During the period of this grant, RCBI provided Quality implementation courses and assistance to more than 225 companies and worked with an additional 450 certified companies across the service region with updates, gap analyses, internal audits, etc. More than 50 companies became registered to or compliant with various management standards as a direct result of RCBI assistance, while still others improved their practices because of RCBI efforts.

Because of Quality implementation assistance from RCBI, ADI Services, Allevard-Sogefi, Aurora Flight Sciences of West Virginia, Azimuth, B/E Aerospace, BF Goodrich, Becker/SMC, Bombardier, Compton Metals, C.U.E Inc., Extreme Endeavors, FMW Composite Systems, Inc., Level 1 Fasteners, Kanawha

Electric & Machine, Lockheed Martin, Kvaerner Power, Mustang Survival, The National Biometrics Security Project, Pratt & Whitney Aircraft Services, Special Metals, Star Technologies, TRAMCO, Valtronics, Inc. and West Virginia Manufacturing Solutions, to name a few, are registered to or compliant with various quality management systems that are required for them to remain DoD suppliers.

To reinforce its commitment to the quality approach that it advocates, RCBI hosted a regular network meeting of the (Ohio) Section of the American Society for Quality (ASQ). The regularly scheduled event included networking, tours of RCBI and live demonstrations of the cutting edge technologies available for use by manufacturers and entrepreneurs.

RCBI provided assistance to the West Virginia Army National Guard, which included ISO 9001 Quality Management; ISO 14001 Environmental Management; Six Sigma Green Belt; and Problem-Solving, Root Cause Analysis and Corrective Action Training. Without this quality assistance from RCBI, including Six Sigma and ISO 9000, civilians serving in the military could not have refurbished military vehicles, including Humvees and transport equipment tires. The assistance was responsible for securing more than 125 civilian jobs with an estimated 100 additional trained staff. This skilled workforce enabled the Army National Guard to refurbish weapons platforms and Humvees, as well as recondition field service tools including fire extinguishers, tire jacks, shovels, hand tools and other accessories directly from the war theater, then re-issue them to military units stateside at a cost savings of 60 percent to the federal government. With networking assistance and manufacturer capability assessment from the RCBI 21ST Century Manufacturing Network (**www.21stmanufacturing.org**), the West Virginia Army National Guard was able to locate quality-based and capable manufacturers to rebuild hydraulic jacks and support the overhaul of valves, spools, hoses and other tools.

A continuing – and expanded – highlight involved Kanawha Electric & Machine. Among its other productions, this small manufacturer refurbishes generator motors that are being returned to Iraq. RCBI provided ISO 9000 implementation and documentation assistance to the manufacturer so it could become compliant and begin the registration process. The company, with RCBI assistance, follows the necessary military specs and requirements in the re-manufacturing process for the motors. The motors are being sent to Kanawha Electric from the Iraqi theater, refurbished at company's operations in Charleston, W.Va. then shipped back for the soldiers' operations. An additional element to this success story is the development of a portable compressor that supports pneumatic tools as well as deployment of and ease of use of disposable fuel cell bladders (for Humvees and other military vehicles including supply trucks). The first phase order of six prototypes, which were built, tested and have proven successful has progressed to a limited-rate-production milestone order of an additional 600 units. It is anticipated that this portable compressor has the potential benefit to the military to reach into the thousands of units of production and deployment.

Information Technology in place at RCBI is designed to meet the electronic commerce needs that present unique opportunities to manufacturers. Nearly 550 manufacturing companies participated in the RCBI 21ST Century Manufacturing Network, a computerized clearinghouse that allows manufacturers to network with each other and reach new markets. The network allows participants to market, team, convert documents, electronically communicate via e-mail and conduct other collaborations on line. This effort enhances the strength of the electronic chain of DoD suppliers across West Virginia and the region.

THE RCBI 21ST CENTURY MANUFACTURING NETWORK

RCBI had a positive, measurable impact during the term of the grant with its 21ST Century Manufacturing Network (**www.21stmanufacturing.org**), an electronic network that linked (and continues to connect) its members with each other and to the world.

The RCBI 21ST Century Manufacturing Network supported procurement efforts to enhance West Virginia's DoD supplier base through access to electronic network parts catalogs, including the Defense Logistics Agency (DLA) as well as a variety of other DoD sourcing centers and prime contractors including TACOM, TROSCOM, Cherry Point Naval Station, ASO, DI, DG, DISC, FAA, FBA, the SBA Office of Technology, NASA, the Naval Electronic Warfare Center, Naval Facilities Engineering Command, PAX River Naval Air Station, the Army National Guard, DSCP, DSCC, the U.S. Corps of Engineers and the DoE. Through access to bid opportunities from these electronic resources, RCBI facilitated the existence

of a quality, just-in-time, cost-effective, competitive, alternative, DoD supplier base. RCBI accomplished this task by providing technical information, reverse engineering assistance, digitization of blueprints, three-dimensional computer models, 3D Printer prototyping and document bid technical packages on sole source DoD parts to interested manufacturing firms across the region. Participants in RCBI's electronic network continue to actively support DoD requirements.

Nearly 340 DoD and other government agency contract opportunities valued in excess of $810 (M) million have been submitted by West Virginia manufacturers. The RCBI 21ST Century Manufacturing Network guided the companies and entrepreneurs as they successfully bid on and were awarded nearly $400 (M) million worth of such contracts, which ranged from the manufacture of textiles, metals and electrical components to weapons components and spare and repair parts for military vehicles. The expanding list of contract recipients include Air Robotics LLC; Ashland Machine; Aurora Flight Sciences of W. Va.; Azimuth; B/E Aerospace; Bombardier; Compton Metals; DeVall Brothers; Douglas Barrels Inc.; Extreme Endeavors, Inc.; FMW Composite Systems Inc.; GPR Enterprises; Green Pack, Inc.; H & H Pallets; Huntington Plating, Inc.; Industrial Plating and Machine, Inc.; Industrial Rubber Products; Kanawha Electric & Machine; Lanny Williams, Inc.; Lenco Machine; Machine-Tech, Inc.; Meadow River Enterprises; Mustang Survival; Pressure Products; Quality Components; RF Manufacturing; Star Technologies; Stainless & Alloy Supply Company; Swanson Plating; TRAMCO Machine; Tri-State Roofing and Sheet Metal; Vintech; Walhonde Tool, and West Virginia Manufacturing Solutions, Inc.

Internally, to ensure better, more secure, cost-effective communications and linkages – and measurable results – between RCBI daily operations and the 21ST Century Manufacturing Network, RCBI implemented an electronic database, **SalesForce.com**, that integrated a real-time view of current RCBI client activity with potential on-line DoD contract opportunities. In addition, during the period of this grant, RCBI implemented a new back-end, Coldfusion server with an upgraded SQL 2005 server. This technology allowed RCBI to automate much of the bid identification process so it was easily, regularly and readily available to manufacturers in the 21ST Century Manufacturing Network.

DoD Supply Chain Program/Business Development

RCBI continued to strengthen DoD supplier chains across the region by ensuring technical resources were available to meet industry requirements. This focus brought quality-based manufacturers together with appropriate DoD production, testing and prototype needs. RCBI's Business Development team efforts worked to identify and distribute government contracting opportunities to manufacturers across the service region. The focused, experience provided by RCBI helped clients maintain sales quotas, generate business leads and properly manage their teams as valuable participants in the RCBI 21ST Century Manufacturing Network. RCBI's team assisted clients through DoD registration sites, coordinated workshops and maintained databases. RCBI positioned itself to work closely with the region's manufacturing sector to match the critical needs of DoD agencies and their primes to West Virginia manufacturers' technical abilities.

Participants in the RCBI 21ST Century Manufacturing Network offered production assistance for components of the Bombot, a cost-effective robot that disables and disposes of improvised explosive devices. From the manufacture of aluminum payload baskets to other basket mounts and components for the robotic units, RCBI assisted to ensure that quality companies across the state and region were directly involved in supporting military requirements that help keep U.S. forces in Iraq and Afghanistan out of harm's way.

Examples of RCBI's Business Development that occurred during the period of this grant include:

RCBI identified a manufacturing opportunity for a DoD contract to produce and deploy disposable fuel cell bladders. Through its 21ST Century Manufacturing Network, RCBI determined companies that could bid on the job. Two manufacturers, Kanawha Electric & Machine and FMW Composite Systems, ultimately were awarded contracts. With engineering and software assistance from as well as access to cutting edge technologies at RCBI, both manufacturers delivered on these contracts valued in excess of $27 (M) million.

RCBI identified manufacturers in its 21ST Century Manufacturing Network with the capabilities required for a $1.3 (M) million contract opportunity involving repair/refurbishment of Humvees for the West Virginia National Guard. Three companies submitted bids and one of them, West Virginia Manufacturing Solutions, was awarded the contract. The contract was successfully fulfilled.

RCBI provided design and development assistance to Kanawha Electric & Machine in the manufacture of a new field-ready double-actuator compressor unit for the U.S. Marine Corps. The portable compressor supports deployment and activation of disposable fuel cell bladder units used to refuel vehicles in the field. RCBI assisted with design and development of the prototype-unit, and provided leased-time use on its computer-controlled CNC Press Brake to produce aluminum tubing and ancillary framework components, prior to final assembly by the West Virginia manufacturer at its facility. Without access to RCBI's cutting edge equipment as well as design assistance, programming and technical training, Kanawha Electric couldn't have fulfilled requirements to complete this contract.

RCBI assisted with prototyping of a West Virginia's manufacturer's capability to supply the U.S. military with advanced Biometrics technology. RCBI facilitated a DoD prime contractor's use of a north-central West Virginia manufacturer to produce a composites casing with advanced electronic hardware and software for face recognition, fingerprint, dentex, vision, voice recognition and SmartCard applications.

RCBI offered *Introduction to Biometrics* training sessions, in partnership with the National Biometric Security Project, for industrial settings, power generation plants and related organizations that needed to incorporate the role of Biometrics for security and identification.

RCBI successfully fulfilled DoD obligations and expanded support to ongoing military operations in Iraq with a Biometrics identification security checkpoint device and to the U.S. National Guard with distance learning opportunities to develop and strengthen the DoD supplier base across the region. The Biometrics checkpoint device was flown on C-17s from Yeager Airport in Charleston, W.Va, to Baghdad, Iraq. The contract, worth in excess of $13 (M) million, was produced for the Marine Corps' Special Operations by Azimuth Inc. of Morgantown, West Virginia, a small business that participates in the RCBI 21ST Century Manufacturing Network. RCBI assisted the prime contractor (Azimuth) in identification of materials and components for the production as well as with identification of capable small, veteran-owned machine shops across West Virginia that served as subs.

Mineral Fabrication & Machine Co. constructed prototype components to support the Hubble Space Telescope Servicing Mission (SM3). To enable this project RCBI delivered ISO 9000 Quality implementation and assessment assistance as well as engineering design support, without which Mineral Fabrication couldn't have successfully delivered on this $1 (M) million contract.

A supply of electronic communications circuit boards was secured and supplied for DoD agencies, including the U.S. Army, as a result of Business Development involving quality initiatives. Superior Manufacturing Services in Beaver, W. Va., needed internal auditor assistance and training to satisfy ISO 9000 requirements. The manufacturer turned to RCBI for help and the result was a successful contract for the communications equipment.

RCBI successfully coordinated the first-signed-in-West-Virginia NASA Space Act Agreement with private industry. The NASA Langley Research Center signed the agreement with Extreme Endeavors Consulting of Philippi for an extreme low frequency acoustic measurement system to be deployed in cave surveillance. This effort expanded to test case scenario and was deployed by the National Guard for training active military personnel. The system offered the potential to be used overseas in numerous remote areas in the Mid-East theater to support our nation's homeland security initiatives.

RCBI expanded the technological capabilities in Science and Technology through partnership with the NASA Goddard Space Flight Center. More than $20 (M) million in government contracts were awarded to West Virginia manufacturing and fabrication companies. One southern West Virginia machine shop, that is ISO 9000 certified, was added to the approved vendor list to supply metal-machined components to NASA. This vendor is capable of precision machining and fabricating space flight-critical hardware. Another West Virginia manufacturer, FMW Composite Systems Inc., completed work on several contracts from the NASA Goddard Space Flight Center to manufacture space optical bench components as well

received an R & D opportunity to design, develop and produce a prototype Super Lightweight Interchangeable Carrier (SLIC) pallet through a multi-phase contract.

With RCBI support of quality and engineering requirements as well as for CAD/CAM software and programming aspects, regional manufacturers were able to produce titanium matrix component materials (TMC) for aircraft landing gear for the Joint Strike Fighter and brake rods for (commercial aviation) Boeing 777 and 787. As a result of this type of RCBI technology assistance, Airbus S.A.S. contracted with FMW Composite Systems Inc. of Bridgeport, West Virginia, to produce brake rods for its Airbus A340, and expanded FMW capabilities to support aerospace shuttle-related missions. RCBI provided technical training in proper hand lay-ups and the curing process of advanced composites materials for the Global Hawk UAV and multiple machining and programming operations. Because of the successful deployment of the TMC materials for the Airbus A340, FMW Composite has begun company expansion efforts that include building a new production facility. This expansion involves a high-pressure, intense heat material-curing technology. The effort further impacted the regional economy with construction of a 50,000-square-foot facility, where in the first year a phased-in employment approach created 12 additional production jobs.

RCBI provided access to cutting edge technologies as well as assisted in the development and fabrication of new and advanced composites materials for DoD and NASA needs. With expansion into the composites and advanced materials production markets, RCBI became the the East Coast's Regional Technology Center for Advanced Composites Production and Training. The Composites Center provided technical training and technical assistance opportunities to 152 manufacturers. In addition, the Composites Center provided technical training to more than 1,179 individuals representing nearly 76 regional companies from the titanium metal matrix composite; filament winding; carbon fiber; glass filament; high-end plastics; high-end fiber glass cloth; kevlar material; ceramics; aluminum honeycomb; Dynel fabric; coal foam; wood; and rubber compound sectors. Expansion and diversification into composites catapulted a 600 percent growth in the market for the region.

To further expand access to new technologies and comply with more stringent defense requirements, RCBI provided enhanced engineering support with installation and use of Mastercam, SURFCAM, GibbsCAM, Esprit, FeatureCAM, AutoCAD, Autodesk Inventor, and SolidWorks software capabilities. These software capabilities enhance the required tolerance targets and strict quality compliance. In addition to technology software access, RCBI provided the only hands-on AutoCAD, Autodesk Inventor, SolidWorks, Mastercam and FARO Arm's CAM2 software training courses across the region.

RCBI assistance was extended into the eastern panhandle of West Virginia as well as through Maryland with support to businesses that provided manufacturing services as part of an Indefinite-Delivery, Indefinite-Quantity contract for NASA. The contract, which ran three years, was successfully completed. It involved the manufacture of fabricated items and engineering services for government machined-prototypes that were utilized for form, fit & functional models. The models were used to verify that the proposed design could be properly assembled with the other components. RCBI assisted in CAD/CAM software development and, in turn, the manufacture of accurate models, which allowed engineers to verify the design for initial assembly as well as for disassembly and maintenance. RCBI's continuous support & assistances was required for these contracting opportunities to ensure cost-effectiveness and manufacturability, so design changes were possible prior to the final manufacture of metal components by participants in the RCBI 21ST Century Manufacturing Network. The critical components were produced from common & exotic advanced materials such as stainless steel and aluminum as well as titanium, invar, inconel, delrin and other exotic metals that were often engineered and produced for use in military operations and our nation's Space program.

West Virginia manufacturers, Aurora Flight Sciences of West Virginia, Alliant Techsystems, Azimuth Incorporated, Bombardier, Eagle Glass and FMW Composite Systems Inc. and Kvaerner Power, earned contracts valued in the millions of dollars to manufacture metal and composite components (including sight glass components; DoD Biometrics components; aviation nose cone retrofits; the Wing, Aft V-tail Wing and Fuselage for the Global Hawk UAV as well as enhanced ground-to-air and air-to-air weapons systems and aircraft landing gear for the Joint Strike Fighter.) To design, develop and manufacture critical components in a quality, timely manner, regional manufacturers utilized fabrication and machining

services for metals and composites-manufacturing needs at the RCBI Bridgeport facility. Advanced machinist skills training, undertaken at Rocket Center for Alliant Techsystems, ensured that its employees were diversified to undertake specialized workforce development initiatives that are critical to the nation's homeland security. RCBI provided training to the members of the first line Composites team involving a Navy-owned cop-op, so that they could fulfill their role in the Global Hawk programs as well as continue to bid on additional enhanced weapons systems.

RCBI had positive, measurable impacts during the term of the grant in Distance Learning Tools and partnered with national providers such as ToolingU to provide direct access to more than 500 expanded on-line topics that range in content from training machine operators, welders, assemblers, inspectors and maintenance professionals. This online technology expanded the reach of training initiatives available to further the mission of meeting critical federal and state DoD requirements. In addition, RCBI's own integrated distance learning system allowed instructors to originate training programs from any area of the service region and reach well beyond the primary RCBI service region.

The RCBI Quality group continued to work with the region's small manufacturers readying them to bid on contracts to manufacture products for the DoD and NASA. RCBI's program remains flexible and customized to take the manufacturer to the desired level of certification in – or compliance with – appropriate ISO, AS or QS standards. Across the region RCBI identified 450 certified companies that are capable of assisting the DoD. Quality assistance continues by providing companies with documented quality management systems and recognized management skills.

Workforce development courses covering customized AutoCAD, Autodesk Inventor, Mastercam, Pro Engineer, Solid Edge, SolidWorks and SurfCAM software training were delivered to B/E Aerospace, BF Goodrich, Bayer Crop Science, Dominion Transmission Inc., Engines Inc., Innovative Screen Technology, Kenny's Machine Service, Lenco, Northrop Grumman, Pratt-Whitney, Pressure Products, UCAR Carbon and other West Virginia manufacturers. The courses provided an overview of basic computer-aided design principles and uses that focused on -- and met -- critical needs across the aerospace industry. Composites and Lean Manufacturing courses were delivered to Lockheed Martin, Bombardier, Blackheart Industries, FMW Composite Systems, KCI Aviation, Kvaerner Power, the NASA Marshall Space Flight Center in Huntsville, Ala., Sino Swearingen, Alliant Techsystems, Eagle Glass Specialties, Inc., Aurora Flight Sciences of West Virginia, UCAR Carbon/GRAFTech, the West Virginia Air National Guard and more than a dozen other companies across the region.

Specific examples of RCBI's DoD-directed technical assistance projects include:

- Provided technical assistance including design, reverse engineering and production guidance to Kanawha Electric & Machine for a new double actuator compressor for the U.S. Marine Corps. With this assistance, the manufacturer produced a prototype model of a redesigned compressor unit that has improved applications for use in the field to support military transport vehicles and Humvees. The contract, potentially worth $12 (M) million moved to the test phase prior to full-rate production during the term of the grant.

- Leased production time on computer-controlled equipment, including the Amada Pulsar 1212XL 2000-watt Laser Cutter, to Star Technologies to machine multiple styles of airframe brackets, clamps, fasteners and ancillary components made from stainless and carbon steel to inconel alloys for aerospace jet engines and military aircraft.

- Provided design, engineering, development and manufacturing assistance to Air Robotics LLC, a start-up company whose primary product is an unmanned Airborne Vehicle System (AVS). The Service-Disabled Veteran-Owned business designs and manufactures the blended wing-body vehicle, predominantly used for remote sensing and airborne applications, made of a closed-cell foam composite material. The vehicle is designed to carry a wide variety of sensors including electro-optical (EO), infrared (IR) and chemical sensors, provides real-time, persistent intelligence, surveillance and reconnaissance (ISR) of a focused area for more than four hours with clandestine operation at 200 feet AGL (above ground level). The manufacturer presented a small piece of balsa wood wing material and identified a need to mount a motor to the wing structure. Using dimensions provided by the manufacturer, RCBI assisted in the production of a plastic prototype, using the Fortus 900mc 3D

production system. Using SolidWorks software, RCBI assisted in the production of a solid 3D model then manufactured samples that were uniform and structurally sound. Air Robotics received a $1.3 (M) million DoD contract. This aerospace manufacturer's unique capabilities present the potential creation of additional workforce members to expand production in West Virginia to meet military theater and homeland security needs.

- Delivered a customized SolidWorks software training workshop and engineering assistance that ranged from blueprint reading and reverse engineering measurements from the FARO Laser ScanArm to the production of CAD/CAM drawings for the staff of B/E Aerospace. With RCBI training, the company also utilized Geomagic Studio and Rapidform XOR software to reverse engineer aircraft de-icing boots. The resulting CAD models helped the company establish baseline models for future tooling needs as well as successfully meet its quality control analysis needs for the mechanical device.

- Provided reverse engineering assistance with FARO arm technology which made it possible for B/E Aerospace to deliver on a nearly $9 (M) million contract to produce specialized hovercraft skirting for amphibious LCAC (Landing Craft Air Cushioned) transports for U.S. Navy SEALs. Without access to the specialized technology and assistance available at RCBI, the company could not have performed this work.

- Provided ISO 9000 Implementation and Documentation assistance to Kanawha Electric & Machine so the Kanawha County manufacturer could compete successfully for a contract to refurbish generator motors for military operations in Iraq.

- Provided reverse engineering assistance using the FARO Arm to Advanced Systems Supportability Engineering Technologies and Tools, or ASSETT Inc., an engineering and design firm involved in complex electronics systems and digital technologies with military and commercial applications. The company approached RCBI to assist with precision measurements for quality control to verify dimensions of a re-designed electrical control panel for use in a submarine. The panel was developed in collaboration with Lockheed Martin and the United States Navy. Using FARO Arm technology, RCBI determined that the panel met specs, it was installed in the submarine and the project was successful.

- Assisted Alliant Techsystems (ATK) with production of prototype molds using the Fortus 900mc 3D production system and its advanced materials capabilities to manufacture molds for circuit board potting applications in hours. This tooling application reduces time-to-production by eliminating the time-consuming machining process, which often took as long as three to four weeks.

- Produced prototype components for Air Robotics to test form, fit and function of new designs on a model of its unmanned Airborne Vehicle System so the manufacturer could be identified on an approved GSA vendor supply list. This action opened new market opportunities to the manufacturer.

- Utilized the FARO Arm and performed quality control checks for FMW Composites on tooling it used to manufacture composite aircraft components for the F-18 Strike Fighter as well as a variety of commercial aircraft applications for Boeing Aircraft, GE Engines and Rolls Royce Engines.

- Assisted Sherwood Advanced Composite Technologies with production of 3D drawings, CAD/CAM modeling, programming assistance and CNC router machining of advanced composite molds and tooling for unspecified DoD applications.

- Provided engineering design assistance, training, prototyping and machining to MarTek Ltd., the maker of a battery-powered switch that enabled manufacturing plants, mines, hospitals and other users to comply with OSHA protection requirements in the operation of circuit breakers. After RCBI introduced MarTek to the West Virginia Small Business Development Center, the company received a start-up grant that allowed the company to take its product to full-rate production. All of the metal components in the switch are manufactured at RCBI. The manufacturer received training to program and operate computer-numerical-control (CNC) equipment available for lease at RCBI and now can program, inspect and produce parts with minimal assistance. The company's customers include the Department of Defense, NASA, Oak Ridge National Laboratory and a virtual Fortune 500 list of companies including

American Electric Power, Chevron Phillips, Dow Chemical, DuPont, Exxon Mobile, Northrop Grumman, Pratt & Whitney, Weyerhaeuser and others.

- Utilized the Faro Laser ScanArm in conjunction with Geomagic Studio and Rapidform XOR software to reverse engineer various obsolete shaft-components for Tri-State Coating & Machine Co. Inc. Tri-State then used the resulting CAD models with the Fortus 900mc 3D production system available at RCBI and produced patterns in various casting processes to re-manufacture propeller shafts used on U.S. Navy vessels.

- Collaborated with the Center for the Robotic Servicing of Orbital Space Assets, which is located in Fairmont, W.Va. and was established as part of a cooperative partnership with the NASA Goddard Space Flight Center, to manufacture components for military satellite refueling service missions. RCBI produced rapid prototype models on its Fortus 900mc 3D production system as well as machined metal alloy components for prototypes used in this endeavor.

- Provided software engineering and programming assistance, workforce training and access to RCBI's McClean Anderson WSH Flex Filament Winder technology to Williams International, a composites manufacturer to produce a carbon fiber cylindrical casing for a classified DoD weapons platform.

- Assisted Azimuth Incorporated of Morgantown, West Virginia, with the manufacture and on-site guidance for installation of the first prototype carbon-fiber laminate sheet-console panel on the marine vessel USNS Guardian, operated by the Combatant Craft Division (CCD) of the Naval Surface Warfare Center's Carderock Division (NSWCCD) in Potomac, Maryland.

- Assisted Kanawha Electric & Machine with design and development of portable compressor units for use by military in the field of operations to support Humvees and other military vehicles. Further, RCBI assisted with initial manufacture of aluminum-tubing components as well as the frame for portable compressor units.

- Leased production time on RCBI's Northwood 5-axis CNC Router, and provided technical expertise, to Aurora Flight Sciences of West Virginia to manufacturer composite doors for the Sikorsky MH53 transport helicopter for U.S. Marine Corps use.

- Provided ISO 9000 Implementation and Documentation assistance to Kanawha Electric & Machine so the Kanawha County manufacturer could refurbish generator motors for military operations in Iraq.

- Provided Certified Soldering Training to Alliant Techsystems.

- Assisted Aurora Flight Sciences of West Virginia with prototyping of sono-buoy launchers for Sikorsky helicopters division requirements from the U.S. Navy.

- Assisted Aurora Flight Sciences with chaff dispenser composite units to reduce helicopter weight and enhance corrosion resistance for the U.S. Army.

- Assisted Touchstone Research Laboratory with Shared Manufacturing support (on the newly-retrofitted 6-axis) and Mastercam training to complete component parts for DoD applications, including parts for Sikorsky Aircraft's Black Hawk program.

- Assisted Compton Metals of Clarksburg with SurfCAM software training and CNC production capabilities, which enabled the Harrison County manufacturer to support BISA, the Biometric Identification System for Access. This DoD project enhanceed military force protection initiatives for U.S. installations in Iraq and other hostile theater environments.

- Continued Shared Manufacturing support and technical assistance (ranging from engineering assistance, production preparation, manufacturing and critical inspection of components) to Aurora Flight Sciences of West Virginia, which manufactured a prototype of aircraft wing molds for the Global Hawk UAV (Unmanned Aerial Vehicle). Without access to the niche technologies offered at RCBI, specifically the 6-axis Machining Center at RCBI Bridgeport, the manufacturer would not have been able to even submit a cost-effective proposal to perform this work. Further, RCBI provided CMM and FARO Arm assistance for digitization and verification of production dimensions to ensure the components met U.S. Air Force requirements.

- Provided access to computer-controlled production equipment to manufacturers including Azimuth, Compton Metals, Kanawha Manufacturing and Kvaerner Power for military robots.
- Provided bid proposal development and fabrication/machine rate cycle time projection assistance to Terramite Corp. for a contract to manufacture robotic loader/backhoe that met military needs.
- Assisted Extreme Endeavors of Philippi with an agreement to develop innovative cave monitoring technology involving acoustics that had DoD applications and uses.
- Provided quality training to Superior Manufacturing Services, which enabled the company to qualify to supply electronic circuit boards to DoD agencies including the U.S. Army.
- Provided Blackheart International with CNC production capabilities as well as technical production assistance in the manufacture of AK-47 assault rifle barrel parts for the U.S. military.
- Identified and tested manufacturing techniques for Kvaerner Power to produce robotic parts for DoD use. The robotic design disabled and disposed of explosive devices in combat or hostile environments without exposing its operator to danger. RCBI provided prototyping assistance and reverse engineering (using a FARO Arm) as well as CNC machining of various robotic parts. RCBI assisted in the identification of West Virginia manufacturers (through the 21ST Century Manufacturing Network) that were capable of supplying components for the robot.
- Leased production time on the Amada Pulsar 1212XL 2000-watt Laser Cutter and Okuma "CADET" BB CNC Turning Center to Star Technologies for manufacture of steel pieces for Abrams tank and alloy-component washers for G. E. aircraft engines.
- Assisted FMW Composite Systems Inc. with quality and engineering requirements as well as CAD/CAM software and programming assistance that enabled the manufacturer to produce titanium matrix components for aircraft landing gear for the Joint Strike Fighter and brake rods for (commercial aviation) Boeing 777s.
- Assisted Azimuth Inc. with CAD/CAM, prototyping, Shared Manufacturing and production of aluminum lids and cabinets for hand held computer cases for the U.S. Navy.
- Assisted Mustang Survival with bid preparation for contract to manufacture air crewmen survival rafts, military-issue flotation devices as well as other life-saving garments and equipment for DoD uses. All branches of the U.S. military have long used Mustang Survival products, which offer superior safety solutions – on, over and in the water; for aviators and ground forces. With the ongoing assistance of RCBI, the company's West Virginia plant secured a series of continuing DoD contracts.
- Assisted FMW Composite Systems Inc. with Shared Manufacturing and CNC production of fuel cell bladder components for the U.S. Marine Corps. As a result, the production was done in West Virginia at the RCBI Bridgeport facility with a reduction in costs conservatively placed at 30 percent for the U.S. Marine Corps.
- Assisted FMW Composite Systems Inc. with Shared Manufacturing of full-rate production of titanium matrix-based composite-components for the Joint Strike Fighter for U.S. Air Force and Navy requirements.
- Assisted Garrett Container Systems with prototype assistance for DoD shipping containers.
- Assisted Greater Maryland Tool with Shared Manufacturing and CNC production of stainless steel and exotic metal socket head cap screws, sockets, studs and worm drive parts used in U.S. Navy nuclear vessels.
- Assisted Industrial Rubber Products with bid preparation for the manufacture of spray nozzles with a variable orifice flow rate with 20 gpm and 50 psig in its range. The nozzles were used in federal laboratories.
- Assisted Mineral Fabrication & Machine Co. with Shared Manufacturing and CNC production of aluminum components for the Hubble Space Telescope and other replaceable tooling parts.

- Assisted CM&M Development with preparation of five bids for the manufacture of parts (Back Plate Latches and Front-Sight Blades) for the M240 machine gun, machine keys for the 155MM Howitzer and feed shaft assemblies for the M242 Gun used in Bradley Fighting Vehicle System.
- Assisted Lenco Machine with bid preparation to manufacture electrical jackscrews for the M1A1 Tank.
- Assisted Ashland Machine with bid preparation to manufacture barrel nuts for small arms weapons for the U.S. military.
- Assisted D & E Industries with bid preparation to manufacture handles for the M198 Towed Howitzer.
- Assisted DeVall Brothers with bid preparation to manufacture spare and repair parts for the Defense Supply Center Columbus.
- Assisted ATK with technical training needs to meet both metals and composites manufacturing needs for the Global Hawk UAV.
- Provided FMW Composite Systems Inc. bid, quality and technical assistance for production components for the Global Hawk UAV.
- Assisted the DoD Biometrics Management Office with destructive testing.
- Assisted Swanson Plating with technical assistance and machining capabilities to support a major defense contractor. This assistance resulted in development of a new company in the region, and added 25 jobs to the region's contingent of skilled workers.

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Weiler
Willis

TECHNOLOGY TRANSFER EFFORTS

A key component Technical Services at RCBI involves manufacturers' access to state-of-the-market manufacturing equipment that otherwise wouldn't be available to them because of its prohibitive expense. Manufacturers across the state and throughout our service region have invested in state-of-the-market manufacturing equipment, both hardware and software, as a result of exposure to and trial use of these types of state-of-the-art and -market, computer-controlled, production equipment available for leased use at RCBI.

More than 200 pieces of computer-controlled manufacturing equipment (including lathes, mills, wire EDMs and water-jet cutters) have been purchased by private industry after initial exposure and access at RCBI Advanced Manufacturing Technology Centers. This Technology Transfer effort represents an investment commitment approaching $32 (M) million by private industry.